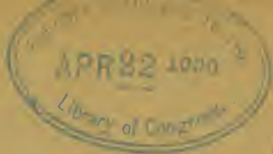


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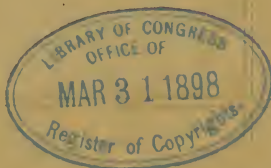
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SUBJECT:

MECHANICAL DRAWING.

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TMP96-024421

MECHANICAL DRAWING.

DIRECTIONS FOR DRAWING PLATES.

DRAWING PLATE, TITLE: DETAILS.

NOTE.—All article numbers and figure numbers which occur in the text, are continued from Instruction Paper, subject, Geometrical Drawing.

46. The first eight figures of this plate show the conventional methods of representing screws. The actual projection of a screw thread will be similar to the projection of the helix shown in Plate V; but, in order to save the time required to locate the points and trace in the curves, the following methods are universally used, except, perhaps, in the case of screws of very large diameter and pitch, drawn full size.

Fig. 1 represents a **single square-threaded screw** $1\frac{1}{2}$ inches in diameter, and $\frac{3}{8}$ inch pitch. To draw the screw, first draw the center line mn , and a line AB at right angles to it. Make the distance AB equal to the diameter of the screw, or $1\frac{1}{2}$ inches, and through the points A and B draw lines AD and BE parallel to the center line mn . Also lay off on the line AB distances AF and BG equal to one-half of the pitch, and through the points F and G draw lines FH and GI parallel to the center line mn . These lines show the depth of the thread. On the line AD , lay off the width of the thread and of the groove, AC , CJ , JK , etc., each equal to one-half of the pitch, or $\frac{3}{8} \times \frac{1}{2} = \frac{3}{16}$ of an inch. Draw the line BC , and through the points J , K , L , M , etc. draw lines parallel to BC . Draw faint pencil lines through the points C and P , J and Q , K and R , etc., to represent the back edges of the threads, and make the parts which are seen full lines; then draw the lines TV , UW , etc. The method of drawing the remainder of the screw, and

the reason for using the heavy shade lines, as shown, should be apparent without further explanation.

It will be noticed that the width of the thread and of the groove, measured parallel to the center line mn , and the depth of the thread, are all exactly the same; that is, they are each equal to one-half of the pitch. If a section were taken through the center line mn , the thread and groove would look like Fig. 71, a series of squares; hence the term *square thread*.

Fig. 2 shows a **double square-threaded screw** $1\frac{1}{2}$ inches in diameter, and with $\frac{3}{4}$ of an inch pitch. The reason for using a double thread is, that if the single square thread were used, the depth would be so great as to weaken the bolt or rod

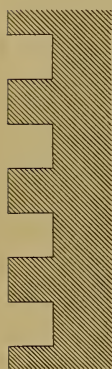


FIG. 71.

on which it was cut, and render it unsafe for the purpose for which it was intended. To prevent this, either the diameter of the rod must be increased or the thread must be cut of the same depth and thickness as a thread of half the pitch, or, in this case, as if the pitch were $\frac{3}{4}$ of an inch $\times \frac{1}{2} = \frac{3}{8}$ of an inch, as in the preceding problem; another thread of the same size and pitch ($\frac{3}{4}$ of an inch) must be cut half-way between these first threads, thus giving a double thread. The pitch, or distance that the screw would advance in one turn, would be $\frac{3}{4}$ of an inch, the same as if it were a single-threaded screw of $\frac{3}{4}$ of an inch pitch, while the depth of the thread is only half as great.

To draw it, proceed exactly as in the last figure. To get the direction of the line BC , which in this figure represents the projection of the bottom edge of the top of the thread, lay off AC equal to one-half of the pitch, or $\frac{3}{4} \times \frac{1}{2} = \frac{3}{8}$ of an inch, and draw the line BC . The width of the threads and grooves, and also the depth of the threads, is one-fourth of the pitch, or $\frac{3}{4} \times \frac{1}{4} = \frac{3}{16}$ of an inch.

Through the points K, L, M , etc. draw faint pencil lines KX , etc., to represent the back edges of the threads, and make those parts which are seen full lines. Through the point K draw a faint pencil line KR , at right angles to the center line mn , intersecting the line FH in a , and draw the line Ta , which

represents the bottom of the thread. The remainder of the screw should now be drawn without any trouble.

Fig. 3 is a **single V-threaded screw** $1\frac{1}{4}$ inches in diameter and having 7 threads to the inch; that is, the pitch is $\frac{1}{7}$ of an inch. Draw a cylinder $1\frac{1}{4}$ inches in diameter, having $m n$ for the center line. Lay off $A B$, $B C$, $C D$, etc., each equal to the pitch, or $\frac{1}{7}$ inch. Do the same on the left-hand side. By the aid of the **T** square and 60° triangle make the angles $A O B$, $F O' G$, etc. The rest of the thread can be drawn by referring to the figure.

Fig. 4 represents a screw exactly like the preceding one, except that the thread is left-handed, instead of right-handed as in the previous case.

To ascertain whether a thread is left- or right-handed, hold the screw in such a position that its axis is horizontal. If the thread is right-handed, as it usually is, the angle which the edge of the thread makes with the horizontal on the right-hand side is obtuse; if left-handed, it makes an acute angle with the right-hand side of the horizontal. No further instruction should be necessary for drawing the thread.

Fig. 5 represents a **double V-threaded screw** $1\frac{1}{4}$ inches in diameter. It has $3\frac{1}{2}$ threads per inch; that is, the pitch is $1 \text{ inch} \div 3\frac{1}{2} = \frac{2}{7}$ inch. The same remarks regarding the drawing of it apply here that were used in describing Figs. 2 and 3.

Fig. 6 represents a section of a **brass nipple**. When the diameter of a nipple is given, the inside diameter is always meant, unless otherwise specially stated. The actual diameter of a nipple or pipe is very rarely given, but must be taken from printed tables. The *nominal diameter* of the nipple shown in the figure is 1 inch, but the actual inside diameter is 1.05 inches; from the table, the outside diameter is found to be 1.32 inches, making the thickness .135 of an inch. Owing to the thinness of the shell, pipe threads are finer than the threads on the same-sized rods. The coarsest pipe thread is 8 threads per inch. The number of threads per inch on the nipple shown is $11\frac{1}{2}$. The thread is tapered to make a tight fit, and the length of the threaded part on each end is $0.52 + 0.53 = 1.05$ inches, of which length the distance between a and b represents the

perfect thread, while from b to c the thread is chamfered ; that is, it dies out gradually. To draw the nipple, make a sectional view as shown. Draw a cylinder, having mn as a center line 1.32 inches in diameter ; lay off the inside diameter equal to 1.05 inches, and draw AB and CD . Now lay off the diameter HK equal to 1.26 inches. Then lay off the distances HJ and KL , equal to $0.52 + 0.53 = 1.05$ inches ; join the points H and J , and K and L , by straight lines representing the top of the threads. Now on the center line mn , or on any line parallel to it, lay off a distance of 1 inch from the line AC downwards. Divide this distance into $11\frac{1}{2}$ parts by means of the method given in problem 6, Art. 31. Project the points just found upon HJ , and, by means of the T square and 60° triangle, draw the threads from H to J as though all the threads were perfect. Draw the threads on KL in the same manner, remembering that the divisions on HJ are to be advanced half a thread, as shown ; that is, the top of one thread and the bottom of the preceding thread on the other side will be on a horizontal line. Now lay off the distance ab equal to 0.52 inch, and project it on lines drawn parallel to KL and HJ , and touching the bottom of the threads. From the points of intersection draw straight lines to J and L , in order to obtain the bottoms of the imperfect threads extending from b to c . Complete the rest of the drawing in the same manner.

Fig. 7 shows another method of representing a V-threaded screw. This method has the advantage of making a neat-looking drawing, and of being very rapid in delineation. The pitch is laid off as in the three preceding figures. The heavily shaded lines represent the bottom of the thread, and their lengths are determined by constructing an equilateral triangle on the pitch distance as shown, and limiting the line to distances between two corresponding vertexes of the triangle. The diameter of the screw is 1 inch, and the number of threads per inch is 8.

Fig. 8 represents the same screw shown in Fig. 7, but the lines indicating the bottom of the thread are left out altogether. This method is used on drawings where haste is necessary. Unless in very much of a hurry, the method shown in Fig. 7 is to be preferred. Ordinarily, when drawing screws as represented

by Figs. 7 and 8, it is not customary to lay off the pitch and the depth of the thread as above mentioned—the distances between the lines representing the threads are simply gauged by the eye; practice will enable this to be done very quickly and accurately.

Fig. 9 shows two views of a small **hand-wheel**. To draw it, locate the center O , and through O draw the center lines tr and mn at right angles to each other. From O as a center, with the compasses set to the radius of the wheel, or $3\frac{1}{4}$ inches, draw the outer circle of the rim; then, lay off the thickness of the rim, which is $\frac{5}{8}$ of an inch, and draw the inner circle. Through O , with the **T** square and 60° triangle, draw the center lines AB and CD . With O as a center, draw two circles, one having a diameter of $\frac{5}{8}$ of an inch, to represent the hole, and the other a diameter of $1\frac{1}{4}$ inches, to represent the outside of the hub. To draw the arms, make the chords of the arcs ab, cd , etc. each $\frac{1}{2}$ inch long. Make the chords hl, ik , etc. each $\frac{3}{8}$ inch long, and draw lb, ha, kd , etc. With a radius equal to $\frac{1}{4}$ of an inch, describe the fillets, or arcs, $A'B', C'D'$, etc. tangent to the arms at A', B', C' , etc. With a radius equal to $\frac{1}{8}$ of an inch, describe the fillets or arcs tangent to the inside of the rim and to the arms. All of these arcs terminate at the point of tangency. The cross-sectioned part on the arm indicates that a cross-section taken at EF would look as shown, that is, that the arm is elliptical.

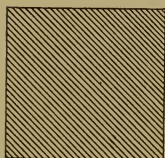
The other view shows a conventional method, largely used in drawing rooms, of indicating a section of the wheel. It is termed a conventional method because it would really be impossible to obtain a section like the one shown. Theoretically, the arm in this view should be sectioned, but, for convenience, a section is imagined to be taken through the rim and hub on the line tr , and the two arms are shown in projection as they appear on the line mn . Draw the center line pq and the sections of the rim, as shown. Draw the arms from the dimensions given. Draw the hub as shown, using a radius of $\frac{5}{32}$ of an inch to draw the fillets or arcs tangent to AB and to the arm; make $O'H'$ equal to OH in the other view, and describe an arc through H' tangent to the two arcs just drawn,

which are tangent to AB and the arm. The rest of the drawing can be completed without further explanation.

Fig. 10 shows a **crank**, which should be drawn without difficulty from the dimensions given. The pin is forced in, and the end riveted over at AB , to prevent it from being pulled out.

SECTION LINES.

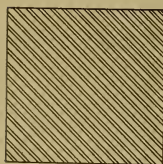
47. The method ordinarily used for indicating the different materials by means of section lines is shown in Fig. 72, in a series of small squares drawn according to the usual method of sectioning the material named at each square.



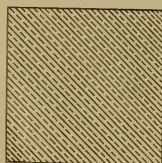
Cast iron, as mentioned before, is indicated by a series of parallel lines equally distant apart.



Wrought iron is sectioned in the same manner, except that every alternate line is shaded.

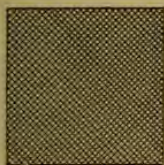


Steel is sectioned by drawing two lines close together, and the third line about $1\frac{1}{2}$ times as far from the second as the second is from the first, and repeating.



Brass is sectioned like cast iron, except that every other line is broken.

FIG. 72.



Babbitt metal is sectioned like cast iron—but in both directions, forming little squares.



Wood is sectioned by a series of rings and radiating lines like the cross-section of an oak tree.

FIG. 72.

SCALES.

48. When it is desired to make a drawing other than full size, special scales are used. Thus, suppose it is required to make the drawing $\frac{1}{4}$ size; then, 3 inches on the drawing would represent 1 foot on the object. Hence, if 3 inches are laid off and divided into 12 equal parts, each of these parts will represent 1 inch on the object. If these parts be subdivided into 2, 4, 8, etc. parts, each will represent $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, etc. of 1 inch on the object. A scale of this kind is called a **quarter scale**, or a **scale of 3 inches to the foot**. An **eighth scale**, or a **scale of $1\frac{1}{2}$ inches to the foot**, would be constructed in the same way, except that $1\frac{1}{2}$ inches would be laid off instead of 3 inches. These scales are written $3'' = 1 \text{ ft.}$, $1\frac{1}{2}'' = 1 \text{ ft.}$

Fig. 73 shows the scale (12 inches long) with which the student should be supplied, and the manner of using it. One edge is divided the whole length into inches and sixteenths of an inch, and is used for full-size drawings. The other edge contains two scales, namely, $1\frac{1}{2}$ inches and 3 inches to the foot, indicated by the figures $1\frac{1}{2}$ and 3 at A and B. It will be noticed that on the scale of 3 inches to the foot the zero mark is at C instead of at G, as in full-size scales. It is put there for convenience in reading feet and inches at the same time. The figures indicating the number of feet on this scale are placed along the extreme upper edge at D, E, and F. To lay off 2 feet

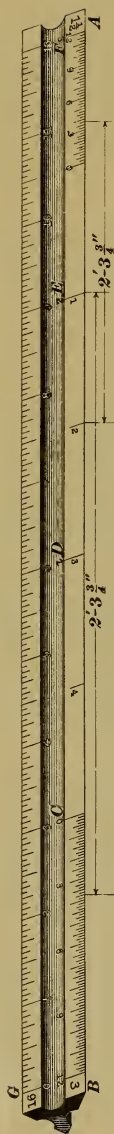


FIG. 73.

$3\frac{3}{4}$ inches from some point, as H , towards another point, as I , place the scale on the point H , so that the 2-foot mark will fall on this point; then, from the zero mark, lay off $3\frac{3}{4}$ inches, as shown, locating the point I . HI will be 2 feet $3\frac{3}{4}$ inches long. The same remarks apply to the other scale of $1\frac{1}{2}$ inches to the foot. To draw to half size, or 6 inches to the foot, use the full-size scale, and remember that every $\frac{1}{2}$ inch on that scale corresponds to 1 inch on the object, that is, that every dimension is only half of the real length. To lay off $5\frac{7}{8}$ inches, lay off 5 half-inches and $\frac{7}{16}$ of an inch over; the result is a line $5\frac{7}{8}$ inches long to a scale of 6 inches to the foot.

If it is desired to draw to a scale of $\frac{3}{4}$ of an inch to the foot, or $\frac{1}{16}$ size, use the scale of $1\frac{1}{2}$ inches to the foot, halving all dimensions, as in the previous case of drawing to a scale of 6 inches to the foot with a full-size scale. It sometimes happens that a draftsman is obliged to make a scale, when the size of his plate is limited and a general drawing of some object is desired. By *general* drawing is meant a complete view of the object in plan, and also one or two elevations. In such a case one scale may be too large to enable the drawing to be made on a sheet of the required size; another scale may make it too small to show up well. For example, an $\frac{1}{8}$ scale may be too large, and a $\frac{1}{16}$ scale too small; a $\frac{1}{12}$ scale may be just right. If the draftsman has no $\frac{1}{12}$ scale (that is, a scale of 1 inch to the foot), he may make one by taking a piece of heavy drawing paper and cutting out a strip about the size of an ordinary scale, and laying off the inch divisions on it. Each division or part will represent 1 foot on the object. Divide one of the end parts into

12 equal parts, and each will represent 1 inch on the object. Lines indicating half- and quarter-inches may be drawn, if considered necessary.

Fig. 74 shows part of a scale made in this manner, giving

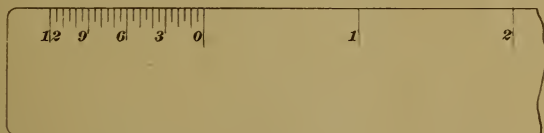


FIG. 74.

feet, inches, and half-inches—the quarters, eighths, etc. of an inch being judged by the eye.

DRAWING PLATE, TITLE: ECCENTRIC AND BRAKE LEVER.

49. Fig. 1 shows an elevation of an **eccentric and its strap**. The strap is made in two pieces, and bolted together with a small space, $\frac{1}{32}$ of an inch wide, between them. Locate the point O , the center of the strap, and draw the center lines AB , mn , CC' , and DD' . Make the offset OO' one-half of the throw of the eccentric, or, $\frac{7}{8}$ inch, as shown, thus locating O' , the center of the eccentric shaft. Construct the rest of the view from the dimensions given, noting that the arc EE' and FF' are concentric with O , while GG' and HH' are concentric with O' . The part $FF'G'G$ is entirely open, and is made so in order to lighten the eccentric.

Fig. 2 is a section of the **eccentric and strap**. The section is drawn in a conventional manner, it being all taken on the line AB , Fig. 1, except that part of the eccentric between G' and F' , where, instead of sectioning, the drawing shows it open from L to P , Fig. 2, as if the section had been taken on the line OJ . This attracts attention to the open part of the eccentric, and shows it more clearly.

It will be noticed that the slope of the threads in the sectional part is the same as for the left-handed screw. The thread, however, is right-handed, and the reason for showing it in this manner is that it is the bottom of the thread that is

being looked at; that is, the section of a right-handed nut and the projection of the bottom of a right-handed screw are the same as the projection of the top of a left-handed screw. It will also be noticed that the sectional lines on the eccentric run in opposite directions to those on the strap. This is always done when two different pieces meet, and serves to indicate that they are separate pieces. Each piece should be sectioned entirely in the same direction, no matter if there is a break, as in the present case, between *L* and *P*. This shows that *A B C D E* is one piece. The dotted hole at *K*, Fig. 1, is an oil hole.

Fig. 3 shows a **brake lever** drawn to a scale of 3 inches = 1 foot. Owing to its length being too great to be shown entirely on the drawing to this scale, the handle is shown as if a piece had been broken out, the dimension line, 4 feet 7 inches, giving the distance between the two centers *O* and *O'*. The lever should be readily drawn from the dimensions given. To proportion it properly, where the size of the paper does not permit the whole of it to be drawn, proceed as follows: The length between the centers is 4 feet 7 inches = 55 inches. The width through *O'* is $2\frac{1}{4}$ inches, and through *O*, 4 inches. Hence, $4'' - 2\frac{1}{4}'' = 1\frac{3}{4}''$; $1.75'' =$ the taper in 55 inches. Measure off *OA* = say, 2 feet. The width at *A* may be found as follows: $\frac{1.75}{55} =$ taper in 1 inch. $\frac{1.75}{55} \times 24 = .76$ inch nearly, the taper in 2 feet. $4'' - .76'' = 3.24'' = BC$, or the width at *A*. Now locate the point *O'*, and from it as a center describe a curve $2\frac{1}{4}$ inches in diameter. Draw lines tangent to this curve, and parallel to the edges between *A* and *O* already found.

It should be noticed that the center of the brake lever in the left-hand view is not situated at the joint where the two parts come together, but coincides with the center of the handle, as it should do.

50. Fig. 75 shows the ordinary conventional method of representing a nut. The bottom of the thread is $1\frac{1}{2}$ inches in diameter, and is represented by the dotted circle; this shows

that it is intended for a screw $1\frac{1}{2}$ inches in diameter. The height of the nut equals the diameter of the bolt or screw on which the thread is cut. The two views on the center line mn should be drawn without difficulty. To draw the curves ea and ad , project b and c at right angles to tv in the points d , a , and e ; pass arcs of circles through e and a , and through a and d tangent to fg , finding the centers of these arcs by trial. The best way of doing this is to draw lines parallel to tv midway between e and a and between a and d . Then, by trial with the compasses, find a center on these lines such that an arc struck with the compasses from this center will pass

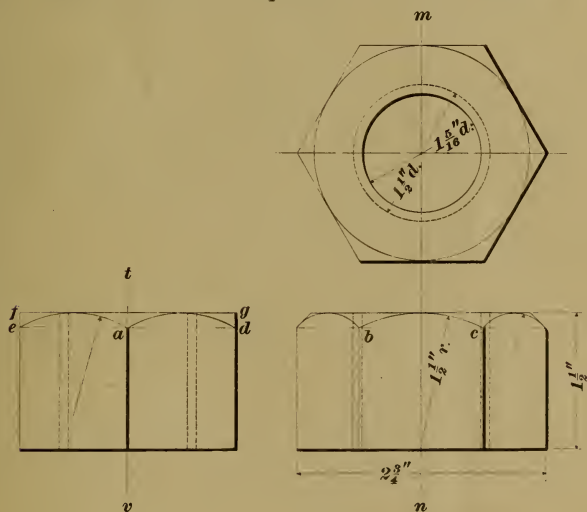


FIG. 75.

through e and a (or a and d) and be tangent to fg . In the right-hand view, the radius of the arc bc is the same as the height of the nut; the centers of the other two arcs are found by trial in the manner just described.

DRAWING PLATE, TITLE: SHEAVE.

51. This plate shows a drawing of a sheave 4 feet 5 inches in diameter, used for transmitting power by rope. In order to

use as large a scale as possible, only half of the side elevation is shown. This is all that is necessary, since the other half is precisely the same. In the lower view, the right half is shown in section, and the left half in plan or projection; in other words, but three-quarters of the sheave is shown, the other quarter is imagined to be removed. This method of representing an object is frequently used in drawing rooms, and saves not only space, but the time that would be required to complete the drawing. The fourteen arms of the sheave are made of wrought iron, the ends being upset and grooved as shown in the section. When casting the sheave, the arms are laid in their proper positions in the mold, the rim and hub being cast around them. The metal flows around inside the grooves and thus prevents the arms from being pulled out. It will be noticed that while one arm extends from the rim to the upper end of the hub (as viewed in the lower figure), the one next to it extends to the lower end; the next to the upper end again, and so on. This arrangement makes a stronger sheave than if all the arms extended to the center.

Having drawn the principal center lines, construct the side elevation. The character of the curves at *A*, *B*, etc. may be more clearly understood by referring to the sectional view. This shows that they are the projections of the intersection of the bosses, through which the arms enter, and the inside of the rim which is made rounding.

These curves may be constructed by finding different points on them, but, for practical purposes, the student may imitate those shown as nearly as he can. The dotted semicircle in the rim represents, of course, the bottom of the groove. The sectional part of the lower view should now be drawn. Lay off $OC = OC' = 4 \text{ feet } 5 \text{ inches} \div 2 = 2 \text{ feet } 2.5 \text{ inches}$. Lay off a distance of 2 inches on each side of *mn* and through the points thus obtained draw lines parallel to *mn* and cutting the projection line *LL'* in *D* and *D'*. These lines represent the outer edges of the rim. With a $\frac{3}{16}$ -inch radius describe arcs tangent to the outer edges of the rim and to the line *DD'*. With a radius equal to $\frac{11}{16}$ of an inch, and a center on *mn*, describe an arc passing through *C*. With a radius of 6 inches describe arcs

tangent to the arc through C , and also to the small arcs already drawn. The centers O' , O'' are found by trial. With C as a center, and a radius equal to $1\frac{1}{2}$ inches, describe the arc which is shown partly dotted; this, of course, represents the inside of the rim. With but few exceptions, all dotted lines have been omitted from the drawing, and only those parts actually seen, have been shown. This was done to prevent the student from becoming confused by a multiplicity of lines. Draw the outline of the entire hub from the dimensions given. Draw the center lines tc and $t'c'$, $3\frac{3}{8}$ inches on each side of and parallel to mn ; these two lines contain all the points of intersection of the center lines of the arms with the hub. Draw the arm G from the dimension given. Project the centers of the bosses J , H , and I upon the center line mn , locating the points J_2 , H_2 , and I_2 , and construct the projections of the bosses themselves. Project J' upon tc , in J_1 . Join J_1 and J_2 by a straight line; J_1J_2 will be the center line of the projection of the arm $J'J$. Project H' upon t_1c_1 , in H_1 , and draw H_1H_2 . Draw I_1I_2 in a similar manner. Finish the sectional view.

The hub is cored out to a diameter of $6\frac{1}{2}$ inches, the recess thus formed being 4 inches long.

The other half of the sheave, which is shown in projection, should be easily drawn without further explanations.

The center lines of the arms $I'I$, I_1I_2 , $H'H$, etc. may be omitted from the finished drawing, as it is not customary to ink them in on shop drawings; the dotted projection lines $I'I_1$, $H'H_1$, $J'J_1$, etc., may also be omitted for the same reason.

DRAWING PLATE, TITLE: REVERSING LEVER.

52. This plate shows a drawing of a **reversing lever**, together with its stand, which is suitable for a brake lever on hoisting-engines. To draw it, first draw the center line mn , the base line AB , and the base and bosses in the side elevation. Locate the center O on mn , 9 inches below AB . With O as a center, and a radius equal to 2 feet 3 inches, describe an arc of

a circle. On each side of mn lay off 12 inches, and draw vertical lines through the points; these lines intersect the arc just described in O' , O' , the centers of the pins. The arc intersects mn in P ; hence, lay off 1 inch on each side of P , along mn , and draw arcs of circles through these points; they will be the limiting lines of the top and bottom of the wrought-iron sector. With the two centers O' and a radius of 1 inch, describe the two circles as shown. Set the spacing dividers to 1 inch, and step off the teeth on the outer circular arc. Draw all the short shaded lines, as ab , radial; that is, if a line be drawn from the point a to the center O , the point b will fall on this line. Measure, from the base line upwards, $CD = 7\frac{1}{8}$ inches, and, with a center on mn and a radius equal to 10 inches, pass an arc through the point D ; also one through E , half an inch below D , using the same center. With a radius equal to 18 inches, find by trial the center Q , which is so located that an arc described with this point as a center, with a radius 18 inches long, will be tangent to the arc just passed through D , and to the circle described about O' . With the same center, and a radius $\frac{1}{2}$ of an inch longer, describe the other arc tangent to the arc through E . Now draw a faint pencil line on each side of, and parallel to, mn , and distant $5\frac{3}{4}$ inches from it. With R as a center, and a 3-inch radius, describe an arc tangent to the perpendicular just drawn, and to the upper edge of the base. Find by trial the center Q' , such that an arc described with Q' as a center, and a radius equal to $19\frac{3}{8} + \frac{1}{2} = 19\frac{7}{8}$ inches, will be tangent to the arc just drawn and to the circle whose center is O' . With the same center, and a radius equal to $19\frac{3}{8}$ inches, describe another arc tangent to an arc described with R as a center and a radius equal to $3\frac{1}{2}$ inches. The construction is the same for each side of mn .

The remainder of this view can be easily drawn from the dimensions given. The dotted part between C and O is a rib; it is shown more clearly in the front elevation, in which FG is its outer edge. The line cde on the top of the lever indicates a flat surface. In the front elevation the line $H'I$ represents the line described with the $19\frac{3}{8}$ -inch and $3\frac{1}{2}$ -inch radii, and the line $H'P$ represents the line described with the 18-inch and 10-inch

radii. Theoretically, the entire rib $FGKL$ should be sectioned, and the outline of the sectional part between N' and N should be dotted, but, for convenience, a conventional method is used. The thickness, $\frac{3}{4}$ inch, of the sectional part, is the thickness of all that part of the arm below the base, except that included between the dotted lines on the side elevation. The dotted line RS is the projection of the edge $R'S'$.

DRAWING PLATE, TITLE: FRICTION CLUTCH.

53. This plate shows a cross-section of a **friction clutch**. The pinion B has a long bearing, and is loose on the shaft S , which runs continually. The brake wheel A is keyed to the hub of the gear-wheel B in such a manner that when A revolves, B revolves also. The clutch C , which has pieces of wood inserted in its periphery, is keyed to the shaft S , and revolves continually with the shaft. The sleeve D is a loose fit on the shaft, and can be moved back and forth by means of a lever or shifter having at its end the collar EE . A feather, not shown, forces the sleeve to turn with the shaft. When D is thrown inwards in the direction of the arrow, the pieces FF are forced outwards. This causes the clutch holding the pieces of wood before mentioned to be forced out likewise. The wood presses against the inside of the brake wheel A , and the friction between the two surfaces causes A to revolve, at the same time turning the pinion B , which engages with a gear-wheel not shown.

It will be noticed by the cross-sectioning that the part of the collar E which is shown is made of wrought iron; that there are two wrought-iron collars H and H' , and two steel washers T and T' . The collar H' is secured to the shaft by means of a set-screw actuated by a wrench, while the collar H is secured by two small screws actuated by a screwdriver, the heads being below the surface of the collar. The steel washer T' is riveted to the collar E .

The student should be able to construct the drawing from the dimensions given.

DRAWING PLATE, TITLE: BENCH VISE.

54. This plate shows a **bench vise and its details**. A drawing of this kind is called a **detail drawing**. Fig. 1 is a complete top view, and Fig. 2 is a section through the center line *CD*. The remaining figures are drawings of the different parts, or details. The actual practice in the drawing-room would be to draw Figs. 1 and 2 first, and then the details, but in the present case the student will do well to draw the details first, as it will help him in drawing the other two views, particularly since nearly all of the dimensions are given on the details. Following out this plan, leave space for Figs. 1 and 2, and begin by drawing Fig. 3. This consists of three views of the jaw, the part marked *A* in Figs. 1 and 2. The parts marked *B*, *C*, and *D*, in Figs. 1, 2, and 3, are circular in shape, so as to permit the back jaw *A* of the vise to swing when the pin *E* is removed. This allows the vise to hold tapered pieces with as much firmness as straight ones.

Fig. 4 is a detail, with dimensions, of the pin *E*.

Fig. 5 is a detail of that part of the vise marked *F* in Figs. 1 and 2, and also of the wrought-iron nut *G*. The reason that only a part of the nut *G* is sectioned in Fig. 2 is that a conventional method has been used. In reality, the whole of the nut should be sectioned. It would be impossible to take a section of the nut in the manner shown.

Fig. 6 shows a top view, longitudinal section, and cross-section of the front jaw. This is cored out to admit the screw and the nut. The form of the cored part is shown by the longitudinal section and cross-section through *EF* and *AB*. The front jaw moves in and out with the screw, as shown by Fig. 2, the collar *L* being held in place by the small set-screw. This is sufficient, since there is no stress on the collar beyond the force required to pull the jaw outwards, the force exerted by screwing the jaws together coming entirely on the surface *M* of the screw head.

A separate detail drawing of the screw is not required, since all the dimensions are given in Fig. 2. Figs. 1 and 2 can now be drawn, the necessary dimensions being obtained from the details.

For ordinary shop drawings, the details are usually drawn to a larger scale than the general drawings, Figs. 1 and 2. In this case the size of the plate would not permit an enlargement.

TRACINGS.

55. In actual practice in the drawing room, it is necessary to have more than one copy of a drawing. It would be very expensive to make a finished drawing every time an extra copy was wanted, and, to avoid this, tracings and blue-prints are made. Any number of blue-print copies can be made from the same tracing. A complete pencil drawing is made first; then, instead of inking in as heretofore, a piece of tracing paper or tracing cloth of the same size as the pencil drawing is fastened to the board over the original drawing. The tracing paper or cloth being almost transparent, the lines of the drawing can be readily seen through it, and the drawing is inked-in on the tracing paper or cloth in the same manner as if inking-in a finished drawing.

Tracing paper is but little used in this country. It is easily torn, and cannot be preserved so well as tracing cloth. The two sides of the **tracing cloth** are known as the glazed side and the dull side; they are also known as the front and the back. The glazed side, or front, is covered with a preparation that gives it a very smooth, polished surface; the back, or dull side, has very much the appearance of a piece of ordinary linen cloth. Either side may be used for drawing upon, but when the glazed side is used, care must be taken to remove all dirt and grease, otherwise the ink will not flow well from the pen. This can be done by taking a knife or a file and scraping or filing chalk upon the tracing cloth; then, take a soft rag of some kind—cotton flannel or chamois skin—and rub it all over the tracing cloth, being sure to rub chalk over every spot. Finally, dust the rag and remove as much of the chalk from the cloth as can be gotten off by rubbing with the rag. The finer the chalk powder is, the better. It is not usual to chalk the dull side, but it improves it to do so. The glazed side takes

ink much better than the dull side, the finished drawing looks better and will not soil so easily, and it is also easier to erase a line that has been drawn on this side. Pencil lines can also be satisfactorily drawn on the dull side, and, if it is desired to photograph the drawing, it is better to draw on this side. The draftsman uses either side, according to the work he is doing, and to suit his individual taste, but if the glazed side is used, *it must be chalked*. The tracings are drawn in a manner similar to the finished drawings, the center lines, section lines, etc. being drawn exactly as previously described.

After having drawn the plate entitled Bench Vise, the student should make a tracing of the plate entitled Friction Clutch.

BLUE-PRINTING.

56. Blue-printing is the process of duplicating a tracing by means of the action of light upon a sensitized paper. The following solution is much used for sensitizing the paper: Dissolve 2 ounces of citrate of iron and ammonia in 8 ounces of water; also, $1\frac{1}{4}$ ounces of red prussiate of potash in 8 ounces of water. Keep the solutions separate, and in dark-colored bottles in a dark place where the light cannot reach them. Better results will be obtained if $\frac{1}{2}$ an ounce of gum arabic is dissolved in each solution.

When ready to prepare the paper, mix equal portions of the two solutions, and be particularly careful not to allow any more light to strike the mixture than is absolutely necessary to see by. For this reason, it is necessary to have a dark room to work in. There must be in this room a tray or sink of some kind that will hold water; it should be larger than the blue-print, and about 6 inches deep. There should also be a flat board large enough to cover the tray or sink. If the sink is lined with zinc or galvanized iron, so much the better. There must be an arrangement like a towel rack to hang the prints on while they are drying. For the want of a better name, this arrangement will be called a print rack. The paper used for blue-printing should be a good, smooth, white paper, and may be purchased of any dealer in drawing materials. Cut it into

sheets a little larger than the tracing, so as to leave an edge around it when the tracing is placed upon it. Place eight or ten of these sheets upon the flat board before mentioned, taking care to spread flatly one above another, so that the edges do not overlap. Secure the sheets to the board by driving a brad or small wire nail through the two upper corners sufficiently far into the board to hold the weight of the papers when the board is placed in a vertical position. Lay the board on the edges of the sink, so that one edge is against the wall and the board is inclined so as to make an angle of about 60° with the horizontal. Darken the room as much as possible, and obtain what light may be necessary from a lamp or gas jet, which should be turned down very low. With a wide camel's-hair brush or a fine sponge, spread the solution just prepared over the top sheet of paper. Be sure to cover every spot, and do not get too much on the paper. Distribute it as evenly as possible over the paper, in much the same manner that the finishing coat of varnish would be put on by a painter. Remove the sheet by pulling on the lower edge, tearing it from the nail which holds it, and place it in a drawer where it can lie flat and be kept from the light. Treat the next sheet, and each succeeding sheet, in exactly the same manner, until the required number of sheets has been prepared.

Unless a large number of prints is constantly used, it is cheaper to buy the paper already prepared. It can be bought in rolls of 10 yards or more, of any width, or in sheets already cut and ready for use. There is very little, if anything, saved in preparing the paper, and better results are usually obtained from the commercial sensitized paper, since the manufacturers have machines for applying the solution, and are able to distribute it very evenly.

57. In Figs. 76 and 77 are shown two views of a printing frame which is well adapted to sheets that are not over $17'' \times 21''$. The frame is placed face downwards, and the back *A* is removed by unhooking the brass spring clips *B*, *B* and lifting it out. The tracing is laid upon the glass *C*, with the *inked* side touching the glass. A sheet of the prepared

paper, perfectly dry, is laid upon the tracing with the yellow (sensitized) side downwards. The paper and tracing are smoothed out so as to lie perfectly flat upon the glass, the cover *A* is replaced, and the brass spring clips *B, B* are sprung under the plates *D*, so that the back cannot fall out. While all this is being done, the paper should be kept from the light as much as possible. The frame is now placed where the sun can shine upon it, and adjusted as shown in Fig. 77, so that the sun's rays will fall upon it as nearly at right angles as possible. According to the conditions of the sky—whether clear or cloudy—

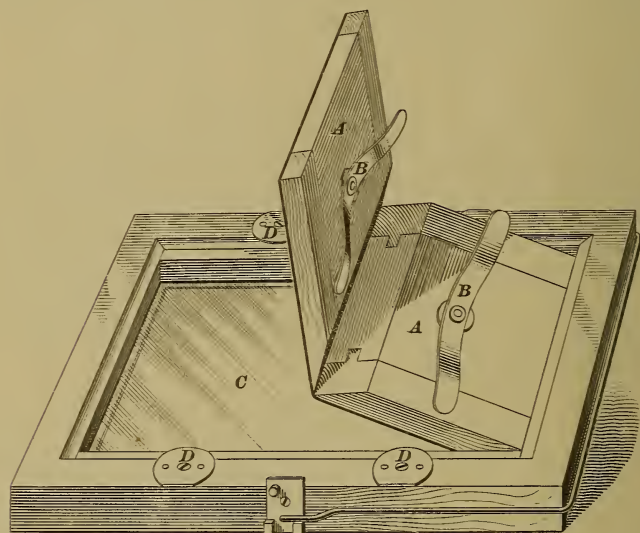


FIG. 76.

and the time of the year, the print must be exposed from 3 to 15 minutes. The tray, or sink, already mentioned, should be filled to a depth of about 2 inches with clear water (rain water if possible). The print having been exposed the proper length of time, the frame is carried into a dark part of the room, the cover removed, and the print (prepared paper) taken out. Now place it on the water with the yellow side down, and be sure that the water touches every part of it. Let it soak while

putting the next print in the frame. Be sure that the hands are dry before touching the next print. The first print having soaked a short time (about 10 minutes) take hold of two of its opposite corners, and lift it slowly out of the water. Dip it back again and pull out as before. Repeat this a number of times until the paper appears to get no bluer; then hang it by two of its corners to dry on the print rack above spoken of. If there are any dark purple or bronze-colored spots on the prints, it indicates that the prints were not washed thoroughly on those spots. If these spots are well washed before the print is dried, they will disappear.



FIG. 77.

58. It is best to judge of the proper time of exposure to the light by the color of the strip of print projecting beyond the edge of the tracing. To obtain the exact shade of the projecting edge, take a strip of paper about 12 or 14 inches long and 3 or 4 inches wide. Divide it into, say, 12 equal parts by lead-pencil marks, and, with the lead pencil, number each part 1, 2, 3, etc. Sensitize this side of the paper, and, after it has been properly

dried, place it in the print frame with the sensitized side and the marks and figures against the glass. Expose the whole

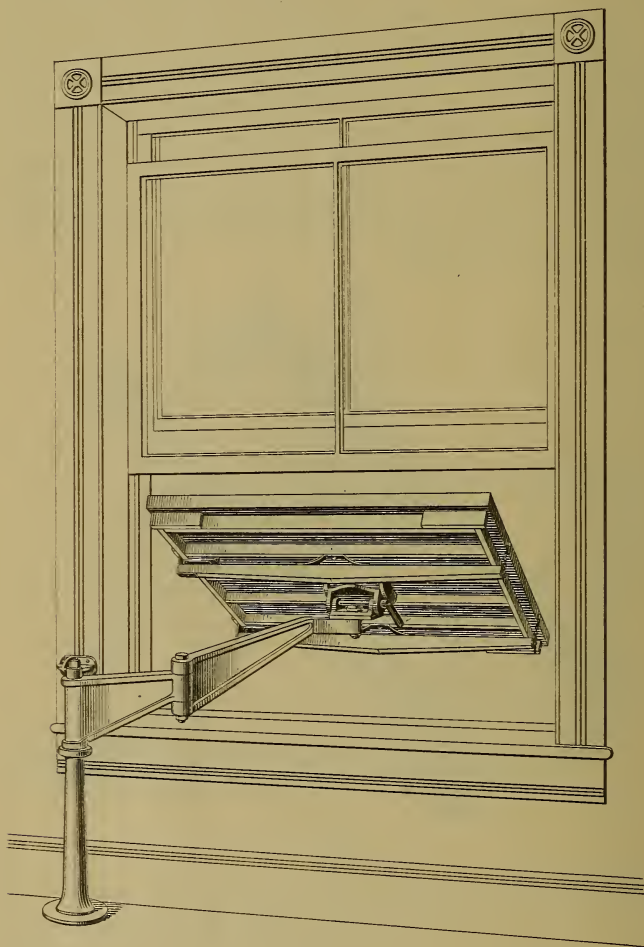


FIG. 78.

strip to the light for one minute ; then cover the part of the strip marked 1 with a thin board or anything that will prevent the light from striking the part covered. At the end of the

second minute, cover parts 2 and 1 ; at the end of the third minute, parts 3, 2, and 1, etc. When twelve minutes are up, part 1 will have been exposed one minute ; part 2, two minutes, etc., part 12 having been exposed twelve minutes. Remove the frame to a dark part of the room, and tear the strip so as to divide it into two strips of the same length and about half the original width. Wash one of the strips as before described, and when it has dried, select a good rich shade of blue, neither too light nor too dark ; notice the number of the part chosen, and it will indicate the length of time that the print was exposed. Examine carefully the corresponding part of the other strip, and the correct color of the edge of the print projecting beyond the tracing is determined. All prints should be exposed until this color is reached, no matter how long or how short the time may be ; then they should be immediately taken out and washed.

In Fig. 78 is shown a patented frame which can be shoved out of the window and adjusted to any angle. When not in use, it can be folded up against the wall, and occupies but little space. It is made in different sizes from 16" $\times$ 24" to 48" $\times$ 72". It is one of the best frames in the market, and is placed in such a position relatively to the window that the window can be lowered to the top of the main arm, when it is desired to keep out the cold during the winter.



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